AD-A171 539 JOSEPHSON EFFECT DETECTORS OF MICROWAVE AND FAR INFRARED RADIATION(U) CALIFORNIA UNIV BERKELEY DEPT OF PHYSICS 31 MAY 86 N00014-85-C-0233 1/1

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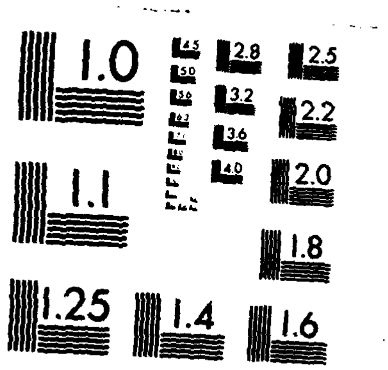

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

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FINAL TECHNICAL REPORT

TO THE OFFICE OF NAVAL RESEARCH

Contract No:	N00014-85-C-0233
Period:	12/1/84 - 5/31/86
Institution:	The Regents of the University of California,
Department:	Physics
Title of Research:	Josephson Effect Detectors of Microwave and Far Infrared Radiation

This contract terminates nearly ten years of Navy support for the invention and development of superconducting quasiparticle heterodyne receivers for millimeter wavelength radiation. Quantum effects such as mixer conversion gain and noise comparable to the limit set by the Heisenberg uncertainty principle have been experimentally observed. Mixer response at 36 and 90 GHz has been studied as a function of parameters such as RF and IF embedding impedance, local oscillator power, bias voltage, junction I-V curve, and operating temperature. Comparisons have been made with SIS mixer theory and good agreement has generally been found. These mixers are being used full time in heterodyne receiver systems at several radio astronomical observatories. They are the lowest noise millimeter wave receivers available today.

A number of activities begun under previous ONR contracts were completed during this contract year. These include the following activities:

1. Completion and submittal of a paper describing "Variable-Temperature Loads for Use in Accurate Noise Measurements of Cryogenically-Cooled Microwave Amplifiers and Mixers." These new technologies permit measurement of the gain and noise of low temperature mixers and amplifiers with unprecedented accuracy. This capability has proved invaluable in demonstrating the performance of SIS mixers close to the quantum limit.

2. Experiments were completed for a systematic investigation of the performance of arrays of SIS junctions in heterodyne mixers. These experiments showed that the conversion gain of mixers is independent of the number of junctions used, that the saturation level and local oscillator powers are proportional to the square of the number of junctions used, and that the mixer noise under favorable circumstances can also be independent of the number of junctions. The dynamic range of SIS quasiparticle heterodyne mixers can be increased by at least three orders of magnitude by the use of series arrays of junctions without any sacrifice in gain or noise. A conference paper "Performance of Heterodyne Mixers Used in Arrays of SIS Junctions" was presented describing these results.

3. In collaboration with a group at Yale University a paper was submitted for publication describing "High Quality Tantalum Superconducting Tunnel Junctions for Microwave Mixing in the Quantum Limit." This paper described an experimental evaluation at 36 GHz of mixers using a new tantalum junction technology. This work obtained mixer noise temperatures less than twice the quantum limit and the lowest heterodyne receiver noise temperature ever reported.

4. Extensive experimental tests were carried out of a new 90 GHz heterodyne mixer block. Versions of the mixer block were tested which had full height and reduced height waveguides. Tests were made with single junctions, arrays of junctions in series, and junctions with a microstrip tuning stub. This mixer block showed extremely wide tuning bandwidth with only one mechanical adjustment. Double sideband mixer noise temperatures as low as 6.6 K were observed. Conversion gain was seen when a high impedance IF system was used. This design has very desirable features for practical applications of SIS mixers.

Although a remarkable amount of progress was made, not all of these projects were completed during the contract year. Air Force funding has been received for extending SIS mixer work to higher frequencies. This funding will be used to complete the write-up for publication of the experiments on series arrays and the experiments on the new mixer block. It is also anticipated that high quality tantalum tunnel junctions will be tested in the new 90 GHz wideband mixer block.

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